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New Record of *Ganoderma colossum* White Rot on *Ficus bengalensis*

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ABSTRACT

Ganoderma colossum is a rare species of Ganodermataceae family with many biological and biochemical properties. It is associated with rot, wilt, dieback, and wood decay of many host plants such as *Ficus carcica*, *Celtis laevigata*, *Pinus hondurensis*, *Callitris robusta*, *Eucalyptus citrodora*, *E. paniculata*, *E. puncata*, and *Phoenix canariensis*. In Oman, this pathogen was isolated as new records from *Delonix regia*, *Ficus altissima*, *Phoenix dactylifera* (2005-206), *Sclerocarya birrea* (2013), and *Ziziphus spina-christi* (2014). In the present investigation, the fungus was detected as a white rot on the base and the upper parts of the trunk, and on the exposed root of *Ficus bengalensis*. Based on the morphological characteristics and microscopy of the specimens, the pathogen was identified and confirmed with the deposited herbarium materials and the available data. This is thought to be the first record of *G. colossum* white rot on *F. bengalensis* worldwide.

Key Words: Dieback, *Ficus bengalensis*, *Ganoderma colossum*, Oman, white rot.

INTRODUCTION

Ficus bengalensis L. (Indian banyan) of the family Moraceae is evergreen tree native to different areas of Asia such as Thailand, Southeast Asia, Southern China, Malaysia, and grown in parks, and botanical gardens throughout the tropical regions (Neel 1965; Riffle 1998; Mandal *et al*. 2010). It is important tree in the Sultanate of Oman which grown on roadsides, parks, and public gardens as shade plant. Various parts of plant (root, leaves, stem, and latex) possess medicinal uses for ulcer, gonorrhoea, vomiting, diarrhoea, dysentery, diabetes, and rheumatism (Nadkarni and Nadkarni 1982; Nadkarni 2006). The ethanolic extract significantly reduced carrageenan-induced paw edema in rats (Vishnu and Anupama 2010). It contains significant anti-inflammatory potential effects for both a cute and sub-chronic inflammations (Manoj and Urmila 2008; Vishnu and Anupama 2010). Phytochemical analysis showed the presence of phenol, flavonoids, and terpenoids which significantly inhibited colonidine induced catalepsy in mice (Mukherjee and Saha 1998). It shows many activities as antidiarrhoeal (Mukhejee and Saha 1998), immunomodulatory (Gabhe and Tatke 2006), antimicrobial (Uma and Prabhakar 2009), allelopathic effects (Jayakumar and Eyini 1998), and antidiabetic (Gayathri and Kannaabiran 2008). In Oman, our research is mainly focusing on the invasion of economically important trees with different fungi and their potential threat and

distribution throughout the country (El-Nagerabi and Elshafie 2014). From 2014 to 2015 some trees of *Ficus bengalensis* in Al-Dakhileyah province, center of Oman, displayed various symptoms of yellowing, wilting, undersized leaves, dieback of the branches, and extensive fungal growth on the stems and root area. The fungus was identified and found to be *Ganoderma colossum* which was reported before on different Omani trees (*Delonix regia*, *Ficus altissima*, *Phoenix dactylifera*, *Sclerocarya birrea*, and *Ziziphus spina-christi*) (Al-Bahry *et al*. 2005; Elshafie *et al.* 2006; Elshafie *et al.* 2013; El-Nagerabi and Elshafie 2014). It was not previously detected on *F. bengalensis*.

MATERIALS AND METHODS

In Al-Dakhileyah provinve, Oman, some *Ficus bengalensis* trees exhibited yellowing of the leaves and dieback of the branches and eventually death of the tree which associated with massive growth of shelf/bracket fungus on the exposed root areas (Fig. 1), the base and the upper parts of the trunk (Fig. 2). The basidiocarps measure 13.4-33.5 cm in diameter and 3.6-5.8 cm thick. The fruiting bodies of the fungus were collected, dried in open air at room temperature (25-30ºC), and their morphology was reported. The mature basidiocarps were scratched to release the basidiospores and were then examined microscopically using wet mount preparation (Fig. 3). The identification of the fungus was confirmed using relevant taxonomic books and monographs (e.g. Steyaert 1972) and compared with previously identified basidiocarps and deposited specimens in local herbarium at Sultan Qaboos University, and International herbarium of Kew Garden, UK.

RESULTS AND DISCUSSION

Taxonomy

The fungus *Ganoderma colossum* (Fr.), C.F. Baker of the Basidiomycota, Ganodermataceae is a polypore and bracket like fungus. The basidiocarps are pileate, sessile, spongy to woody, grown in fan-like structures, roughly round, obtuse to entire or smoothly undulate margin, white to cream when young, slightly yellow to brown in coloor at maturity. The basidiocarps had diameter of 18.5-39.6 cm on the root (Fig. 1) and 13.4-33.2 cm on the trunk of the tree, 3.5-5.4 cm thick on the margin, and the thickest region of the attachment to the plants measure 13.7-14.2 cm (Fig. 2). Under the microscope, the basidiospores are pale brown to brown, ovate, ellipsoid, rounded base with truncate to narrowly round apex, bitunicate walls attached together with obvious inter-wall pillars (Fig. 3). The average basidiospores measured 13.5-18.7× 6.8-12.7 µ. The morphological description of the basidiocarps and basidiospores of the detected *G. colossum* is identical to the previously identified specimens at Kew Garden herbarium (Specimen No. K[M]137380) and to other isolates previously reported in Oman on *Ficus altissima*, *Delonix regia* (Al-Bahry *et al.* 2005), *Phoenix dactylifera* (Elshafie *et al.* 2006), *Sclerocarya birrea* (Elshafie *et al.* 2013), and *Ziziphus spina-christi* (El-Nagerabi and Elshafie 2014).

Epidemiology and Biology of the disease

Ganoderma colossum (Fr.) C.F. Baker is a devastating disease apparently invades a wide range of woody palnts. It is a pantropical species which was first described in Costa Rica occurring on *Ficus carica*, *Phoenix cacariensis*, and on *Celtis laevigata* in the USA (Adaskaverg and Gilbertson 1988), and in Vietnam on *Delonix regia* (Kleinwächter 2001). The pathogen caused root and stem rot of pines (*Pinus hondurensis*), *Callitris robusta*, and the death of several *Eucalyptus species (E. citrodora*, *E. paniculata*, *E. puncata*, and *E. maculata*) in South Africa (Lückhoff 1955). The external symptoms of this disease in *P. hondurensis* manifest themselves either by gradual yellowing and dying of foliage, or by blowing over the tree due to the weakening of the root collar by extensive rot. In case of *Eucalyptous,* the trees had all died standing as a result of a disorder of the root system and massive invasion of the cambium tissues by the fungus. This white rot fungus can cause wood decay of *Phoenix canariensis* (Adaskaverg *et al.* 1991). Of the white rot fungi, *G. colossum* causes the greatest weight loss (81%) by degrading starch holocellulose, removes greater amount of lignin, eroded the cell wall, degraded middle lamellae, and nearly hydrolysed the starch grain during wood decay (Adaskaverg *et al.* 1991). The herbarium specimens of *G. colossum* kept at RBGK were originated from Saudi Arabia (date palm), Malaysia and Sierra Leone (oil palm), Pakistan (bamboo), and reported on *Gmelina arborea* from Nigeria. In Iran, the pathogen was reported on fallen logs of hardwood and conifers and as weak-wound parasite penetrating through injured tissues of living trees causing white rot (Moradali *et al.* 2007). The fungus has also been reported from Australia; however, the speciem was not available for verification (Smith and Sivasithamparam 2003). The fungus showed many biological activities but not been widely used and explored to date (Weng *et al*. 2010). Phytochemical analysis of the fungus revealed new triterpenoid metabolites (colossolactones 1-7) (Kleinwächeter *et al.* 2001). Components of *Ganoderma* have several medicinal effects such as inhibition of cell transformation, antibacterial activity, immunomodulatory, and free radical scavenging (Hong 2004; Ofodile et al. 2012). Four new lanostane triterpenes, colossolactone V, colossolactone VI, colossolactone VII,

Fig. 1. Basidiocarps of *Ganoderma colossum* invading the exposed root area of *Ficus bengalensis.*

Fig. 2. Basidiocarps of *Ganoderma colossum* invading the trunk of *Ficus bengalensis*.

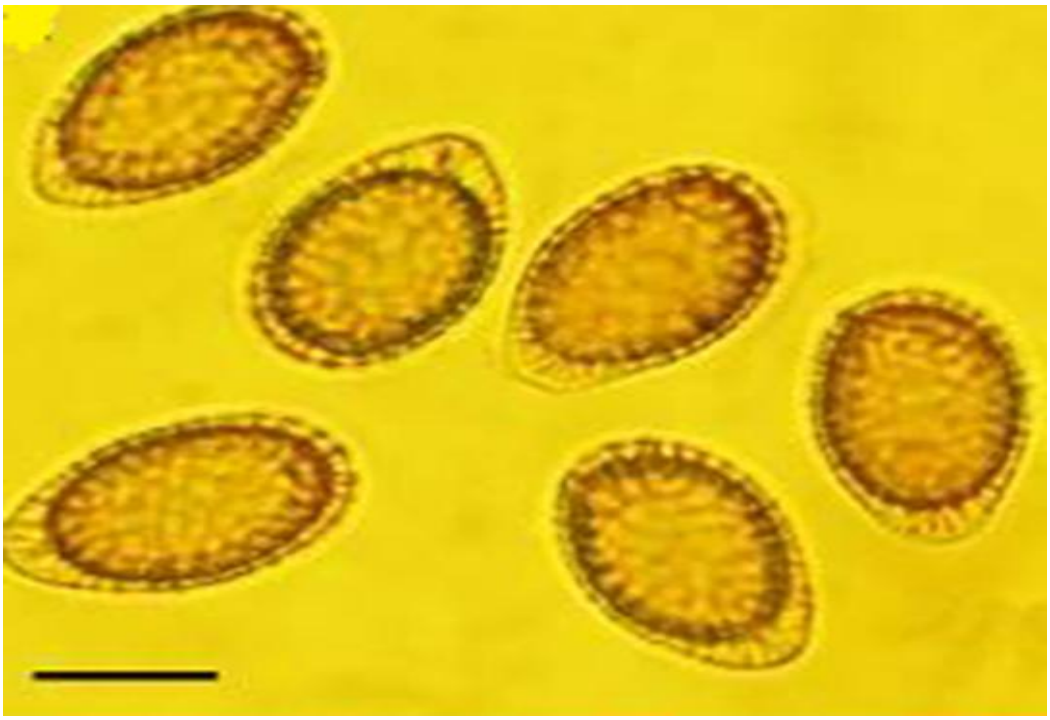

Fig. 3. Basidiospores of *Ganoderma colossum*. Scale bar = 10 µm

and colossonlactone VIII were isolated from Vietnamese mushroom *G. colossum* and evaluated for inhibition of HIV-1 protease (El-Dine et al. 2008). The ethanol extract prepared from the fruiting body of *G. colossum* was effective inhibitor on the phorbol-12-myristate-13-acetate (PMA)-induced invasion of hepatoma cells (Weng et al. 2010). In Oman, the pathogen has been reported on lofty fig (*Ficus altissima*), and flame tree (*Delonix regia*) (Al-Bahry *et al.* 2005), date palm (*Phoenix dactylifera*) (Elshafie *et al.* 2006), causing dieback of marula (*Sclerocarya birrea*) (Elshafie *et al.* 2013), and associated with the dieback and wood decay of *Ziziphus spina-christi* (El-Nagerabi and Elshafie 2014). In the present study, the pathogen was recorded for the first time on the roots, and on the base and upper parts of the trunks of *Ficus bengalensis*. It is apparent that this fungus spreading throughout the country causing deadly diseases to economically important trees. Therefore, our future studies are designed to detect the sources of infection, biology, phytochemical properties and molecular diversity. This will help in adopting effective control strategies and eradication measures.

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